1761 AF

AMENDMENT TRANSMITTAL LETTER

Docket No. M4065.0069/P069

Application No.	Filing Date	Examiner	Group Art Unit
09/121,528	July 23, 1998	Meeks	1762

Applicant(s): Garo J. Derderian

Invention: CONTINUOUS GOOD STEP COVERAGE CVD PLATINUM METAL DEPOSITION

TO THE ASSISTANT COMMISSIONER FOR PATENTS

Transmitted herewith is an amendment in the above-identified application.

The fee has been calculated and is transmitted as shown below.

CLAIMS AS AMENDED

	Claims Remaining After Amendment	Highest Number Previously Paid	Number Extra Claims Present	Rate	
Total Claims	57	- 57 =		x	
Independent Claims	6	- 6 =		x	
Multiple Dependent Claims (check if applicable)	☐				
Other fee (please specify): Petition For Two Month EOT					390.00
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT:					390.00

☒ Large Entity ☐ Small Entity

☐ No additional fee is required for this amendment.

☐ Please charge Deposit Account No. _____ in the amount of _____.
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Dated: January 18, 2001

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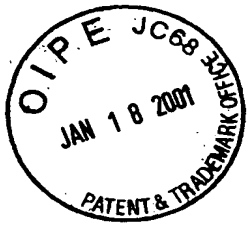
PATENT
Docket No.: M4065.0069/P069

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Garo Derderian



#19
1/30/01

Serial No.: 09/121,528 Group Art Unit: 1762

Filed: July 23, 1998 Examiner: T. Meeks

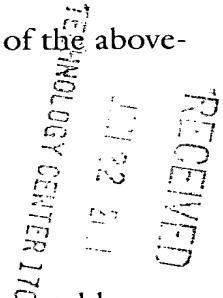
For: CONTINUOUS GOOD STEP COVERAGE CVD PLATINUM METAL DEPOSITION

Box AF
Assistant Commissioner for Patents
Washington, D.C. 20231

AMENDMENT UNDER 37 C.F.R. § 1.116

Dear Sir:

In response to the Office Action dated August 18, 2000 (Paper No. 17), finally rejecting claims 1-4, 6-10, 12-36 and 46-68, Applicant submits a petition for a two-month extension of time, filed concurrently herewith, and requests reconsideration of the above-identified U.S. patent application in light of the following remarks:



REMARKS

Claims 56-68 stand rejected under 35 U.S.C. §103 as being unpatentable over Baum et al. (U.S. Patent No. 5,783,716). The Office Action recognizes that Baum is completely silent as to the "flow rate at which oxygen/nitrous oxide is delivered to the chamber," and, more specifically, that Baum does not disclose or suggest the claimed

combined oxygen/nitrous oxide flow rate in the range of about 1500 sccm to about 2500 sccm. (Office Action at 2). To overcome this shortcoming, the Office Action states that "the flow rate of oxidizing gases to the chamber is a result effective parameter and it would have been a matter of routine experimentation to determine appropriate amounts . . . to optimize removal of carbon from the film." (Office Action at 3). The Office Action then asserts that, although "Baum et al. are silent as to the deposition times and Pt film thicknesses . . . these parameters are clearly related and the thickness is a function of the intended purpose." (Office Action at 2).

This rejection is traversed. As the Office Action recognizes, Baum provides virtually no guidance as how to conduct the process, leaving everything undisclosed. Baum is silent as to the flow rates of gases. Baum is silent as to the deposition times. Baum is silent as to the film thickness. Baum is further silent as to Pt film qualities, such as smoothness and uniformity, and most importantly, good step coverage, which the inventor seeks to obtain. Baum does not even disclose platinum based film by CVD deposition using a non-reactive gas which is bubbled over an organic platinum based metal precursor. Baum uses instead direct liquid delivery for volatilizing a source reagent liquid solution. (Col. 3, lines 24-65). Baum is silent as to the operating conditions of the liquid delivery apparatus because Baum is concerned with eliminating "the deleterious effects of having oxygen in contact with capacitor oxides at high temperatures (i.e., ≥500°C)" (Col. 5, lines 1-3), which Baum achieves by simply adding nitrogen oxide to oxygen.

The Office Action fails to establish a case of *prima facie* obviousness for the claimed invention. As noted in § 2142 of the Manual of Patent Examining Procedure

("MPEP"), three basic criteria must be met to establish a *prima facie* case of obviousness, one of them being the requirement for the prior art to teach or suggest all the claim limitations. In re Royka, 490 F.2d 981, 180 U.S.P.Q. 580 (CCPA 1974). This way, "all words in a claim must be considered in judging the patentability of that claim against the prior art." In re Wilson, 4242 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (CCPA 1970).

The Office Action has not establish a *prima facie* case of obviousness because not all claim limitations are taught or suggested by the prior art. For example, the limitation of independent amended claim 56 that the "oxygen and nitrous oxide are at a predetermined ratio with a combined flow rate in the range of about 1500 sccm to about 2500 sccm" -- which is a much higher total flow rate than conventionally used in the prior art -- is not taught or suggested by Baum or by any other prior art reference. Further, the limitation of amended independent claim 56 that the platinum group metal is CVD deposited at a temperature of "from about 200 °C to about 300 °C " is also not taught or suggested by Baum or by any other prior art reference cited by the Office Action.

To overcome the lack of deposition parameters[1] in Baum, the Office Action states that the "the flow rate of oxidizing gases to the chamber is a result effective parameter and it would have been a matter of routine experimentation to determine appropriate amounts . . . to optimize removal of carbon from the film." (Office Action at 3). The Office Action then asserts that, although "Baum et al. are silent as to the deposition times and Pt film thicknesses . . . these parameters are clearly related and the

[1] Baum claims that the Pt deposition process using the nitrous oxide/oxygen composition by liquid delivery "eliminates the deleterious effects of having hydrogen in contact with capacitor 'oxides' at elevated

thickness is a function of the intended purpose." (Office Action at 2). This unsupported assertion of "routine experimentation" clearly evidences a lack of a teaching or suggestion in Baum for the claimed invention.

This assertion that the total flow rate of oxidizing gases is a result effective parameter is no more than an unsupported assumption. Determining the total flow rate of oxygen and nitrous oxide as recited by claims 56, 61 and 66 is not a matter of routine experimentation. As explained over the course of prosecuting the claimed invention, and as known by those skilled in the deposition processes in the semiconductor industry, increasing the flow rate of one oxidizing gas decreases at some point the quality of the step coverage of a deposition material mainly because the precursor gas becomes diluted. For example, during the deposition of titanium nitride (TiN), a flow carrier gas, such as helium (He), is flown in a bubbler over tetrakisdimethyl amido-titanium (TD mat) gas precursor. At the beginning of the deposition process, as the flow rate of the carrier gas increases, the deposition rate of TiN and its step coverage increase accordingly. However, at some point during the deposition process, the presence of too much carrier gas adversely affects the deposition rate of TiN and the step coverage because the TD mat precursor gas becomes diluted, resulting in poor step coverage.

Similarly, when argon (Ar) and oxygen (O_2) come into contact with a metal containing gas, such as a platinum containing gas for platinum deposition, there is always a danger of increasing the flow rates of argon and oxygen too much to the point where the

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temperatures (i.e. ≥ 500°C)." (Col. 2, lines 33-36). Nevertheless, in Example 7, Baum utilizes a "substrate temperature between 500° and 700°C" (Col. 9, lines 27-30), which contradicts what Baum tries to achieve.

metal containing gas becomes diluted. Further, an increased flow rate of oxygen is well-known to give higher growth and deposition rates.

In the present invention, the total flow rate of oxygen and nitrous oxide is extremely high compared to the flow rates of the prior art. As illustrated in Examples 1-4 of the Application, the combined flow rate, in a range of about 1500 sccm to about 2500 sccm, of oxygen and nitrous oxide results in a continuous and smooth platinum film. More importantly, the smooth and continuous platinum film has unexpected good coverage, up to 69%, "a marked improvement"[2] over the results achieved under the prior art. (Application at 17, Example 3). As explained above, these results are unexpected because increasing the flow rate of carrier gases typically results in the dilution of the precursor gas and thus in poor step coverage and poor film qualities. Accordingly, the total flow rate of oxygen and nitrous oxide of the present invention is not a mere result of routine or obvious experimentation, as recognized by the Court in In re Waymouth, but rather a marked improvement over results achieved with other total flow rates. Thus, the claimed combined oxygen/nitrous oxide flow rate in the range of about 1500 sccm to about 2500 sccm cannot be considered a result effective parameter as the Office Action asserts. Thus, even if a prima facie case of obviousness was present --- and it is not --- the arguments above and specification example evidence rebuts any such prima facie case.

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[2] In In re Waymouth, 499 F.2d 1273, 1276, 182 USPQ 290, 293 (CCPA 1974), the court of appeals held that unexpected results for a claimed range as compared with the range disclosed in the prior art had been shown by a demonstration of "a marked improvement, over the results achieved under other ratios." Evidence of unobvious or unexpected advantageous properties, such as superiority in a property the claimed compound shares with the prior art can rebut prima facie obviousness." In re Chupp, 816 F.2d 643, 646, 2 USPQ2d 1437, 1439 (Fed. Cir. 1987). Accordingly, a specific ratio of halogen to mercury for producing whiter light by a lamp was held by the Court to be "critical" for attainment of maximum white light emission, and the claimed ratio was not the result of obvious experimentation. In re Waymouth, 499 F.2d at 1276.

Claims 61-68 stand rejected under 35 U.S.C. § 103 as being unpatentable over Baum in view of Kwon et al. ("Kwon").

This rejection is also traversed. Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of oxygen and nitrous oxide as claims 61-68 recite. Furthermore, Kwon does not teach or disclose "a total flow rate [of oxygen and nitrous oxide] in the range of about 1500 sccm to about 2500 sccm," as independent claims 61 and 66 recite. Once again, no case of prima facie obviousness has been established for the subject matter of claims 61-68.

Kwon addresses the relationship between the formation of holes at grain platinum edges on one hand, and the deposition temperature, nucleation and growth rate, and oxygen flow rates on the other hand. Kwon does not address good step coverage of platinum films using a combination of oxygen and nitrous oxide at high total flow rate. If anything, Kwon proves that platinum film qualities are not a result of routine experimentation[3] and that platinum deposition parameters, such as deposition temperatures and time, are not "clearly related to the thickness" of such platinum films, as the Office Action unfairly continues to assert.

Thus, the combined teachings of Baum and Kwon still fail to disclose or suggest that the CVD deposition method be performed with oxygen and nitrous oxide at a total flow rate "in the range of about 1500 sccm to about 2500 sccm," as recited in independent

[3] Kwon addresses ways of improving specific qualities of platinum based films formed by various CVD methods, but does not address achieving good step coverage for platinum films. (See Kwon, at 2850-2851, which, for example, analyses the hole formation at temperatures of about 450°C in contrast with hole formation at about 350°C).

claims 61 and 66. There is nothing in this combination of references, without the improper use of hindsight reconstruction, to motivate the person having ordinary skill in the art to arrive at the instantly claimed method. Accordingly the subject matter defined by the claims 61-68 is not rendered obvious from the combined teachings of Baum and Kwon.

Claims 1-4, 6-10, 12-36, and 46-55 stand rejected under 35 U.S.C. § 103 as being unpatentable over Baum in view of Kwon and Chen et al. (Applied Physics Letters).

This rejection is traversed. The Office Action concedes that Baum does not disclose a pressure. Nevertheless, to overcome the shortcoming of Baum, the Office Action relies upon Kwon, which teaches a pressure of 2 Torr in the CVD deposition of platinum, and upon Chen et al. ("Chen"), which teaches platinum deposition at 760 Torr (atmospheric pressure). In this respect, the Office Action concludes that "it would have been obvious to have used deposition pressures in this range (2 Torr to atmospheric (760 Torr)) which overlaps with the claimed ranges because these deposition pressures would have been expected to be effective for depositing the platinum films by CVD with these precursors." (Office Action at 6-7).

The claimed invention is not obvious over Baum in view of Kwon and Chen. First, Baum is silent as to the operating pressure of the CVD apparatus. Second, even if Kwon recites a deposition pressure of 2 Torr, Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of oxygen and nitrous oxide as presently claimed. Thus, even if Kwon might suggest a platinum deposition at a pressure within the

claimed range, Kwon still does not suggest the claimed chemistry, which is the mixture of oxygen and nitrous oxide at a very high flow rate, of about 1500 sccm to about 2500 sccm, or that the pressure used in Kwon would be applicable to the claimed chemistry or flow rate. Third, Kwon does not teach or disclose a pressure other than 2 Torr. There is nothing to indicate that Kwon's 2 Torr pressure or any greater pressure would be appropriate for a deposition chemistry which includes oxygen and nitrous oxide and at the recited flow rates. Fourth, even if Kwon and Chen could have been modified and combined, "the mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art suggests the desirability of the combination." (MPEP, § 2143.1 citing In re Mills, 916 F.2d 680, 16 U.S.P.Q.2d 1430 (Fed. Cir. 1990). Nothing in Baum, Chen or Kwon suggests the desirability of applying a pressure other than 2 Torr or 760 Torr to a deposition chemistry which includes oxygen and nitrous oxide.

Similarly, Chen recites a deposition pressure of 760 Torr, but does not disclose or even suggest that the platinum deposition be effectuated in the presence of oxygen and nitrous oxide. Chen is also silent about the total flow rate in the range of about 1500 sccm to about 2500 sccm, as independent claims 1, 6 and 25 recite. In fact, Chen teaches a completely different mixture, that is flowing argon and hydrogen over a hot substrate. Further, Chen does not teach or disclose a pressure other than the atmospheric pressure and, again, Chen does not suggest that his pressure could be used with the specifically claimed chemistry. Thus, although Kwon and Chen arguably teach platinum deposition at very specific pressures, it is clear that Kwon and Chen do not teach or suggest that such

pressures or any other pressure would be at all useful with the claimed chemistry and flow rates. Moreover, because each reference uses a different chemistry,[4] it is illogical and improper to define a wide pressure range based on two respective pressure points, one from each reference, much less the claimed pressure range.

Furthermore, Kwon and Chen disclose entirely different chemistries from that employed in Baum. The Office Action disagrees with the Applicant's statement that the references are simply not combinable in view of the diverse chemistries involved in each reference, noting that "[I]n all three processes, there is decomposition of the same precursor to deposit a platinum film." (Office Action at 11). But this statement is not true. Baum discloses platinum deposition by using a variety of solid precursors, such as tetrakis (trifluorophosphine) paltinum, bis (β-diketonate) platinum, (cyclopentadienyl) platinum trimethyl, among others. (Col. 1, lines 42-46). Chen specifically notes that studies were done by decomposition of C*p*PtMe$_3$ prepared by PtMe$_3$I and NaC*p* but using toluene instead of benzene as solvent. Finally, Kwon discloses only deposition by metallorganic chemical vapor deposition using only (methylcyclopentadienyl) trimethylplatinum (MeC*p*PtMe$_3$). It is clear, therefore, that the rejection is based on picking and choosing selected portions of each reference, without regard to the totality of teachings of the references, in an attempt to improperly use hindsight to reconstruct the invention. Accordingly, a person of ordinary skill in the art would not have been motivated

[4] Kwon teaches platinum deposition in the presence of oxygen, in addition to argon or hydrogen introduced into the reactor chamber. Chen teaches platinum deposition in an atmosphere of hydrogen and a stream of flowing argon.

to combine Baum with Kwon and Chen, and withdrawal of this rejection is respectfully requested.

Moreover, Kwon does not suggest or disclose a deposition pressure other than a low pressure such as 2 Torr. Kwon addresses the dependency between the microstructure and electrical properties of platinum films on one hand, and the various deposition conditions, such as temperature, on the other hand. Kwon analyses the impact of only two deposition parameters (temperature and oxygen flow rates) on the nucleation and growth rates of platinum films. For example, according to Kwon, at a 50 sccm oxygen flow rate, "[P]latinum films deposited at 300 and 350°C showed a random orientation, but above 400°C the preferred orientation was (111)." (Kwon at 3). With respect to pressure, Kwon mentions only once that "the Pt source was vaporized at reduced pressure (2 Torr). (Kwon at 1). Kwon is silent on the impact, if any, that different pressures would have on the Pt film properties. More important, Kwon is silent on whether any variation in the deposition pressure could have any effect on the nucleation and growth rates of the Pt film. Thus, Kwon does not disclose or even suggest in any way a range of deposition pressures for which Kwon's experimental data would be valid. Moreover, by showing widely diverging deposition results with minor temperature variations, Kwon further demonstrates the weakness of the Office Action's assumption that the recited high flow rates for the claimed invention, which are not taught in any reference, are merely the results of routine experimentation.

Similarly, Chen does not disclose or suggest a deposition pressure other than 760 Torr (atmospheric pressure). Chen analyses only the impact of low temperatures on an

atmosphere of hydrogen on the deposition of polycrystalline films of platinum. The experiment in Chen involves using toluene instead of benzene as the solvent, with the reaction starting at - 77°C and the substrate being held at 180°C. Chen mentions that "[T]he complex was vaporized at atmospheric pressure and 25°C into a stream of flowing argon." Atmospheric pressure and a temperature of 25-27°C are standard conditions, however, and Chen does not suggest any range of pressure, and certainly not a lower than 760 Torr pressure that would work with low temperature and toluene, and not the conventional benzene as solvent. Chen is silent on any range of very low pressures, such as a range including a pressure of 2 Torr, and certainly discloses no pressure range for the claimed chemistry. Thus, Kwon and Chen together do not suggest any range for the deposition pressure, and certainly not the claimed range of 10 Torr to 1000 Torr.

Thus, Baum in view of Kwon and Chen does not teach or suggest the CVD deposition in the presence of oxygen and nitrous oxide "at a pressure of from about 10 to about 1000 Torr" (claims 1, 6 and 25). Accordingly, claims 1-4, 6-10, 12-36 and 46-55 are patentable over Baum in view of Kwon and Chen.

Claims 1-4, 6-10, 12-36 and 46-55 stand rejected under 35 U.S.C. § 103 as being unpatentable over Kwon in view of Baum and Chen. This rejection is respectfully traversed.

Kwon teaches a pressure of 2 Torr in the CVD deposition of platinum by bubbling argon over a platinum precursor. As conceded by the Office Action, Kwon does not disclose or suggest that the platinum deposition be conducted in the presence of

oxygen and nitrous oxide at a total flow rate in the range of about 1500 sccm to about 2500 sccm as presently claimed. Furthermore, Kwon does not teach or disclose a pressure other than 2 Torr. Nevertheless, to overcome this shortcoming in Kwon, the Office Action relies upon Baum to teach a mixture of oxidizing agents which may include oxygen and nitrous oxide. However, Baum does not suggest in any way how to modify Kwon, because, inter alia, Baum is completely silent on the deposition pressure and uses a different chemistry. The Office Action also relies on Chen to teach a platinum deposition at atmospheric pressure (760 Torr). But, Chen is not concerned with any variation in the deposition pressure and his chemistry is different from those of Baum and Kwon. As explained above, Chen merely lists the 760 Torr pressure, along with the room temperature of 25°C, as standard operating parameters. There is nothing in Chen to even suggest that a low pressure may, or could, work with toluene as solvent under a very low temperature of -77°C. Thus, Baum and Chen do not disclose or suggest how to modify Kwon to attain the claimed invention.

In sum, there is nothing in this combination of references, without the improper use of hindsight reconstruction, to motivate a person having ordinary skill in the art to arrive at the claimed method.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

Dated: January 18, 2001

Respectfully submitted,

By_____

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